FbF Guide # 2

Menu of Triggers for Forecast-based Financing: Step-by-Step Approach to Designing Trigger Options

Introduction

When making a Standard Operating Procedure in a FbF framework, disaster risk managers and decision makers need to select which forecast trigger to use for which action. The menu of triggers is a document, prepared by a technical team, that outlines the "menu" of trigger options. With these options, the humanitarian and/or development teams can decide which trigger to select for each of the prioritized early actions and preparedness for response actions.

Target audience for this guide

The main target audience for this guide are technical teams, mainly working at hydro-meteorological agencies, climatologist and research institutions. Given the nature of the design of a Menu of triggers, which involved not only analysis of hydro-meteorological factors but a sound understanding of risks, it is essential a close collaboration with risk analysis and early warning systems experts.

What is addressed in a Menu of Triggers?

The menu of triggers gives a set of options according to the lead time of the forecast. It answers the following questions:

- What is the hazard? What are the risks? What is the "danger level"?
- How much lead-time can the forecast give us? What are the probabilities at each lead-time?
- If we take action based on this probability, how often will we act in vain?
- How often will this forecast trigger?

A trigger is a forecast that is issued, which exceeds both the danger level and the probability threshold, leading to the initiation of predefined actions. This probability threshold is agreed upon beforehand amongst all stakeholders. In FbF, the trigger will be defined by the attributes of the scientific forecast of a likely extreme event. To trigger is to say yes to taking early action based on a warning (i.e., act to activate the SOP). Once the main hazards that will be tackled through the FbF mechanism are selected, the menu of triggers' options are developed with the following four steps:

1. Review and analyze the available early warning system, risk assessments, and forecasts.
2. Define danger levels for the selected hazards and for the intervention area.
3. Assess the accuracy of the available forecast for the intervention area.
4. Design the menu of triggers – the options for triggering early actions.

The above steps are described in detail below. The menu of triggers can be developed for any hazard, including floods, cyclones, cold waves, heat waves, and droughts.

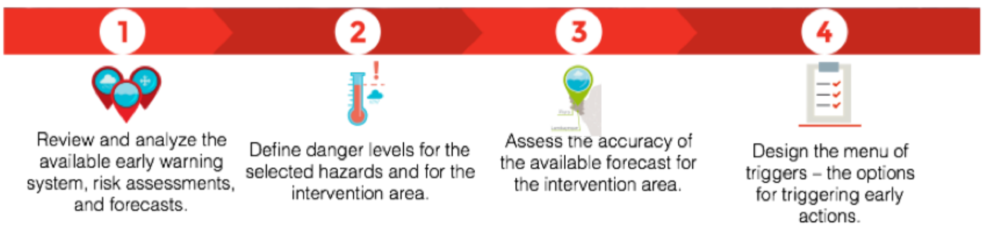


Figure 1: Step-by-step approach to developing a menu of triggers.

Step 1: Review and Analyze the available early warning system, risk assessments and available forecasts

The first step is to identify the existing early warning systems and forecasts available for the selected hazards at the national, regional and global level for the exposed/target area. Review the related information like coverage, accessibility and local expertise in forecast use and interpretation.

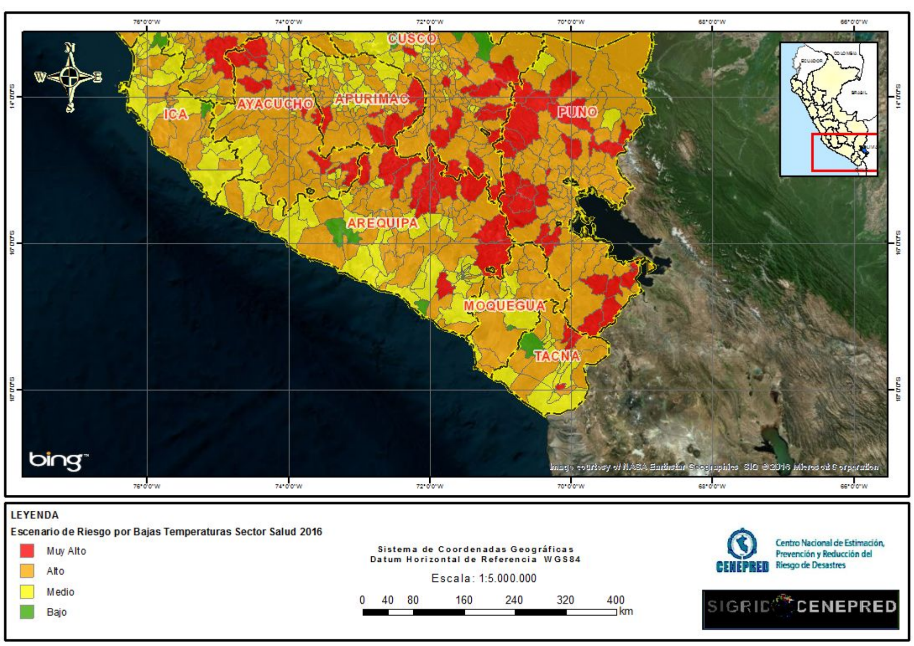
Information should be collected on the forecast coverage over the target area, and the resolution in that region. If a forecast covers the target area, it is required to investigate about its accessibility, such as whether the forecast information is limited to certain organizations or open to all. Lastly, determine whether local experts can already understand and interpret forecast information into a local context, or if translation is necessary.

Table 1: Example of a review and analysis of existing forecasts

	Availability	**Accessibility**	**Local Expertise**
Floods: Bangladesh	Covers more than 60% of the affected region. 5 day deterministic forecast and 10-day probabilistic forecast. Includes flood depth mapping.	Free, web-based, available up to the district level.	Already in use at district levels by disaster management agencies. Requires some translation of forecasted information for easy understanding.
Floods: Mozambique	Regional water administrations.	Available over internet and fax.	Good skills in forecasting event. However danger levels (alert levels) need to be updated to meet current

			vulnerability situation
Cold waves: Peru	High resolution model (10km). 7 days deterministic forecast with bias correction, maps and historical time series available.	Not free on web, but is available in project region.	Used by the Civil Defense for early warning system.
Cyclones: Bangladesh	72 hour rainfall forecast that is translated into ranges. Cyclone track predicted using a global model. Storm surge flooding model not available.	Cyclone warning is available at all levels of administration.	Simple (3 flags system) understandable and used at community level. Effectively used by volunteers for preparedness in communities.
Cyclone: Mozambique	INAM (National met service) produces 3 days lead time. More forecasts and tracks are available in the RSMC- Pretoria web page	Largely disseminated by e-mail, fax and SMS (limited users only)	Good. The early warning system (color code) is well known at all levels from urban to village site and community is trained to take appropriate early actions

At this stage, risk scenarios are consulted and analyzed by all relevant actors. (See Step 1 - Prioritization of Forecast-based actions)



Step 2: Defining the danger level

The danger level (DL) is the magnitude of an extreme event that will lead to an impact (e.g. 100 mm of rainfall over 24 hours). It represents the level at which an excess of or lack of water, temperature, wind, or snow starts to affect the crop production, household's assets, livelihoods, infrastructure, etc. (Note: damages are not only related with crossing the DL but also the event's duration and, in the case of floods, depth). The danger level will depend on the timing of the extreme event and the vulnerability and exposure of a region, and should be updated regularly as the region changes over time.

Impact levels can vary depending on which elements are exposed to a hazard. For example, when a heatwave passes the danger level it may impact human health, but flooding may reach the road height and impact infrastructure. DL can be different for agriculture impacts and household impacts.

There are two main methodologies to define a danger level described here, based on risk assessments and existing vulnerability assessments.

The first way to determine a DL is through observations. For example: "at what height does the river flood these houses", or "at what drought level do the crops fail". This should include a review of secondary sources. Here is a picture of how this was done for a river in Bangladesh by measuring the height of each of the different components of the village. This should include an analysis of existing risk assessments as well as community consultations to define such levels. Techniques for community discussion can include direct observation, livelihood analysis, semi-structured interviews, and focus groups.

Different danger levels

This DL has been set up based on historic and scientific data and validated with the community through consultation process. At each pilot site, at least 2 FGDs have been conducted. The river levels at which the people felt their houses were non-functional was delineated using the community's perspective. In most of the cases they mentioned that it was difficult to function normally if the plinth of their house flooded. One of them mentioned that it was difficult to live if their tube well or toilet submerged. They raised their toilet to cope with such circumstances. They also mentioned in the interview that if the water level went 1.5 feet above the plinth, they had to relocate to another place.

Among the three defined danger levels, DH is critical for triggering the action of the SOP (unconditional grant distribution). That threshold is validated with the community. A bamboo pillar was installed and the community was asked to show at which level HH became hazardous. This level was checked against the level obtained from surveys and found to be very close, with 20-30% of people living below the community defined danger level. All the pilot sites were checked using similar methods, and then finalized the danger levels.

Photograph 1.1: Validation of danger level with community

The second way to define a DL is to look at the historical record. For example, “in the past, what temperatures caused excess mortality”, or “in the past, how much streamflow caused a disaster”. This should include a review of historical information, both quantitative and qualitative. In Uganda, the teams analyzed old newspaper records to understand when flooding had happened in the past, and compiled a record of what river flows were associated with flooding. Read more here. Again, this should include community consultations and participatory risk assessments. For example, techniques from the Vulnerability and Capacity Assessment can be used, including focus groups, semi-structured interviews, seasonal calendar, and historical profiles.

For cold waves in Peru, we worked the historical data of meteorological stations (MET service) close to the selected intervention area. We determined the temperature in several stations (Percentile 10) and correlated this information with the data of historical impacts. In order to corroborate these impacts, the Peruvian Red Cross carried out a diagnosis in the communities (VCA), including focal groups and surveys, which was included to determine the impact level on the population.

Danger level elements	***Climate threshold for specific hazard***	***Historical impact, exposure and vulnerability in area of***	***Political decision*** *(Analyzing data and budgets)*

	(Peruvian Met service)	***Intervention*** *(Civil defense data and Red Cross AVC methodology)*	
Example: Cold Waves	Percentile 10 or 5 for minimum temperature in the winter months (JJAS)	Cold waves in Puno 2013, 2015	Take action 2 times in five years
Example: Floods	Water Level in Iquitos 119 meters above sea level.	Floods Iquitos 2012	Take action 3 times in fifteen years

Distric	Community	Danger level A	Danger level B	Danger level C
Santa Lucia	Orduña	> 20cm Snow and < -12.8°C during 3 consecutives	< -12.8°C during 4 consecutives days	> 40cm Snow for 1 day
Putina	Ticani and Tarucani	> 20cm Snow and < -7.6°C during 3 consecutives	< -7.6°C during 4 consecutives days	> 40cm Snow for 1 day
Potoni	Cullco Belem and Llaulli	> 20cm Snow and < -11.2°C during 3 consecutives	< -11.2°C during 4 consecutives days	> 40cm Snow for 1 day
Macusani	Ccatacancha and Ninahuisa	> 20cm Snow and < -10°C during 3 consecutives	< -10°C during 4 consecutives days	> 40cm Snow for 1 day

Danger levels for differents communities in Peru

Danger levels for tropical cyclones are calculated by combining information from the Tropical Cyclone Category System, rainfall thresholds defined by national meteorological services, historical data and vulnerability assessments. Cyclone categories give information about wind speed, while rainfall amount indicates the chance of floods, and recorded cyclone events are used to assess the exposure and vulnerability of the area. The table below shows the danger levels to trigger FbF early action in Mozambique.

Hazard category	**Thresholds/danger level**			
	Wind speed		**Precipitation**	
Severe tropical storm	maximum sustained wind speed	Wind gust	Total rainfall in 24 h	Total rainfall in 4 consecutive days
	>90 km/h	> 125 Km/h	> 50 mm	> 200 mm

Danger levels in Nicoadala FbF pilot community

Ultimately, it would be best to use a combination of both methods when defining a DL. The key elements to identifying danger levels are:

1) Defining the thresholds for a specific hazard.

2) Identifying critical characteristics, analyzing vulnerability and historical impact of disasters in the area of intervention. (See step 1)

3) Political decision and consensus among key stakeholders. For example, how many times is your organisation of the government willing to act within a space of ten years?

Key questions to ask yourself throughout the process:

- Is forecast/hindcast data to define or calculate danger levels available?
- Is an alarm level already defined by the government?
- What happens if the danger level is reached every year?

Step 3: Assess the accuracy of the available forecast information for the intervention area

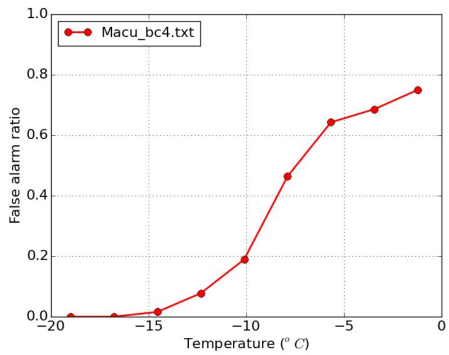
In order to define the triggers, it is important to know the probability of crossing the danger level. In this step, accuracy of the forecast for the respective hazard is assessed for each lead time by calculating the hit rate and false alarm ratios. More lead time means more time for forecast-based actions, but less accuracy means more chance to “act in vain”. There are seasonal, monthly, weekly and daily forecasts of an event.

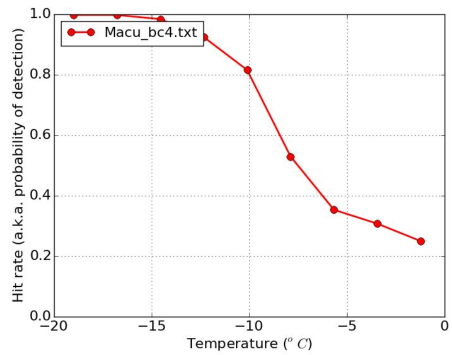
Example from Bangladesh:

The flood early warning in Bangladesh has been carried out by the Flood Forecasting Warning Centre (FFWC) under the Ministry of Water Resources. The FFWC 48hr forecast is highly reliable, which means over 90% certainty, and variation in magnitude (water level) is within 15 cm. Direction also shows a high (H=0.70) hit ratio. The five 5 days forecast has its probability around $p< 0.55$ and error in magnitude is about 0.6 meter, which means it is useful but has low reliability. FFWC also forecasts a 10 days lead time, which has very low probability ($p<0.3$) and mean error in magnitude is over 1.2 meters.

Example from Peru:

Verifications metrics cold wave false alarm ratio and probability of detection





Step 4: Options for menu of trigger identification

Putting all of this together, we then need to define what forecasts can be used in line with the following points:

- What are the different available lead times (short, medium range and seasonal)?
- Does lead time define the type of actions that can be taken between the trigger and the event?
- What is the accuracy of the forecast in relation with lead times in order to choose a feasible action?

The menu of triggers has three criteria; (a) lead time - The length of time between the issuance of a forecast and the occurrence of the forecasted extreme event; (b) accuracy - The Hit Rate and False Alarm Ratio; and (c) frequency – how many times a trigger can happen in a given year.

The table below represents menu of triggers for the pilot sites in the Bogra district. Three options were developed based on the key criteria of lead time, accuracy and frequency. The lead times are 3 days, 5 days and 7 days, accuracy for short term forecasting is done by Hit Rate and False Alarm Ratio which was found to be 0.73 and 0.27 respectively for only 3 days. The frequency an event crossing the danger level needs to be assessed based on forecast information and cross checked with observed data. In the Bangladesh case, it was found that predicted forecasts crossed the danger level every 1 in 10 years, which means the frequency is 1 in 10 years. Based on this information this is the proposed menu of triggers:

Option 1: Take action when there is a forecast with an 84% chance of exceeding damage level (HH plinth level) and remaining above the DL for three days in Bogra project areas, with at least 3 days lead time. This give us a 27% chance of acting in vain.

Option 2: Take action when there is a forecast with a 53% chance of exceeding damage level (HH plinth level) and remaining above the DL for three days in Bogra project areas, with at least 5 days lead time.

Option 3: Take action when there is a forecast with a 20% chance of exceeding damage level (HH plinth level) and remaining above the DL for three days in Bogra project areas, with at least 7 days lead time.

The design of a menu of triggers should be done prior or in parallel to the prioritization of forecast-based actions. FbF guide # 2 will describe the selection process of actions and its link to the menu of triggers.

Examples of Menu of Triggers:

Bangladesh:

1. Floods in Bogra district
2. Cyclones Noakhali district

Mozambique[1] :

1. Cyclones in Nicoadala District

Peru

1. Floods Lambayeque - El Niño[2]

Other relevant documents for reference

1. Forecast-based Action research - Reading University and Red Cross Red Crescent Climate Centre - FbF elements (See chapter 2)
2. Impact-based Forecasting (WMO): WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services
3. The Food Security Climate Resilience (FoodSECuRE) Facility - IRI data sets